CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY
AIR RESOURCES BOARD

EQUIPMENT PRECERTIFICATION PROGRAM

Evaluation of the Air Quality Performance Claims for Curtiss-Wright Flow-Control Valves: Models 100 and 120

June 1998

ABSTRACT

The purpose of this report is to document the Air Resources Board's (ARB's) evaluation and verification of the air quality performance claims made by the Curtiss-Wright Flow Control Corporation (CWFC) concerning its Model 100 and 120 flow-control valves. Upon successful completion of the requirements associated with the ARB's Equipment and Process Precertification Program (Equipment Precertification Program), a report is issued with two companion documents: 1) a certificate; and 2) an Executive Order. These companion documents serve as official records that the ARB has independently verified the performance claims presented in this report.

Certificates earned under the ARB's Equipment Precertification Program are valid for three years from the date issued, presuming the holder of the certificate complies with: 1) the terms and conditions identified in this report; and 2) the general requirements discussed in the <u>Equipment Precertification Program Guidelines and Criteria</u>. In addition, Executive Orders issued under the Equipment Precertification Program identify requirements necessary to retain a valid certificate.

The CWFC has been producing flow-control valves for nuclear power generation facilities since the early 1970's. The flow-control valves, which do not employ a stem, packing, or bellows, were designed to meet the requirements of the Nuclear Regulatory Commission. The CWFC plans to further expand the use of its valves into other industries and believes that becoming certified under the ARB's Equipment Precertification Program will assist with meeting this objective.

As part of its Equipment Precertification application package, the CWFC requested that the ARB evaluate three proposed performance claims with respect to the ability of the subject flow-control valves (Models 100 and 120) to control fugitive emissions of volatile organic compounds. As part of the precertification evaluation, the ARB assisted the CWFC in designing a test protocol to verify the proposed claims. Radian International Limited Liability Company (Radian) was chosen by the CWFC to conduct the testing after the ARB approved the test protocol. During the test, a minor modification to the Model 120 flow-control valve was requested by the CWFC. The ARB approved the change and testing continued as originally planned. After review of the final test results, in conjunction with the other documents discussed throughout this report, the ARB recommends that precertification certificates be issued to the CWFC for flow-control valve Models 100 and 120.

Table of Contents

Contents **Page**

I. INTRODUCTION

This report discusses the technology used by the Curtiss-Wright Flow Control Corporation (CWFC) in the design of its flow-control valves, the performance claims to be verified by the Air Resources Board (ARB), the test procedures used, the test results, and the findings and recommendations of ARB staff concerning the flow-control valves evaluated.

A. Fugitive Emissions of Volatile Organic Compounds

The control of fugitive volatile organic compounds (VOC) emissions from flow-control valves is part of the overall strategy to achieve and maintain healthy air quality in California. Through a series of complex atmospheric reactions, VOCs contribute to the formation of ground-level ozone. As such, federal, state and local air quality programs include strategies to reduce fugitive emissions of VOCs into the atmosphere. These control strategies rely heavily on promoting the development and use of continually improving technologies, as well as periodic inspection and maintenance procedures to ensure that performance is maintained.

The CWFC believes that its flow-control valve Models 100 and 120 are effective at reducing fugitive VOC emissions from a variety of industrial applications. As such, the CWFC submitted an application under the ARB's Equipment Precertification Program. As part of its application package, the CWFC requested verification of the claims that its flow-control valve Models 100 and 120 reliably reduce VOC fugitive emissions.

B. Organization of this Report

This report is organized into several sections. The first section, General Information, provides background information on the ARB's precertification program, as well as the CWFC flow-control valves being evaluated. The next four sections: Summary of Scope; Statement of Claims; Materials Available for Evaluation; and Description of Technology discuss the breadth of our evaluation, the performance claims for the flow-control valves, the information that we relied on to conduct our evaluation, and a detailed description of the CWFC's flow-control valves (Models 100 and 120).

The following three sections: Technical Evaluation; Evaluation of Claims; and Test Results; present detailed information on our technical review and assessment of the performance of the flow-control valves. The sections entitled: Quality Management and Environmental and Economic Benefits provide supporting information on the The CWFC's procedures to produce values which meet the company's claims. These sections also provide a brief assessment of the potential environmental and economic impacts of the technology.

Finally, the remaining sections: Recommendations; Suggested Operating Conditions; and Precertification Conditions discuss the ARB staff's determination of the performance of the valves relative to the company's claims. These sections also provide some general guidance with respect to air quality permitting considerations as well as specific conditions that must be met for the certificate to remain valid for three years. The Appendices contain additional information supporting the evaluation documented in this report.

II. GENERAL INFORMATION

Under the regulations established by the program, equipment or processes eligible for the Equipment Precertification Program must: 1) have an air quality benefit; 2) be commonly-used or have the potential to be commonly-used in the near future (market ready); and, 3) not pose a significant potential hazard to public health and safety and the environment. Furthermore, to be eligible for the program, applicants for the program must demonstrate that they have sufficient control over the manufacture of the equipment or process to ensure that they can consistently and reliably produce equipment which performs at least as well as that considered as part of this evaluation.

A. Equipment Precertification Program Background

The Equipment Precertification Program is a voluntary statewide program for manufacturers of commonly-used equipment or processes. A precondition for entry into the program is that the equipment has an air quality benefit. On June 14, 1996, the ARB adopted section 91400 of the California Code of Regulations which incorporates the Criteria for Equipment and Process Precertification. The regulation and Criteria were approved by the California Office of Administrative Law on October 31, 1996 and became effective on November 30, 1996.

Under the Equipment Precertification Program, manufacturers request that the ARB conduct an independent third-party verification of performance claims which focus on the air quality benefits of its equipment or process. If the claim is verified, the manufacture is free to refer to the results of the ARB's evaluation in its marketing literature. Upon successful completion of the verification process, the applicant may also request that the ARB notify specific air pollution control and air quality management districts (districts) in California of the ARB's determination. As a result of the ARB's notification, the district has an advanced opportunity to become familiar with the performance of the equipment or process.

On June 3, 1996**,** the ARB received a request from the CWFC that ARB determine if its flow-control valves Models 100 and 120 were eligible for the Equipment Precertification Program. After receiving confirmation from the ARB that the flow-control valves were eligible for the program, the CWFC submitted a precertification application package to the ARB. Based on our initial review of the application package, we advised the CWFC that emissions testing would be needed to support the proposed claims. In response, the CWFC contracted with Radian International to perform testing of the flow-control valves Models 100 and 120. Prior to conducting the tests, the ARB staff approved the emissions test protocol. Once the tests were completed, we evaluated the results along with other information concerning the past performance of the flow-control valves to determine whether the claims were verifiable.

B. Relationship to Air Quality

In an effort to make progress towards attaining healthy air quality in California, regulations restrict fugitive emissions of VOCs from a broad spectrum of activities. The reduction of fugitive VOC emissions from flow-control valves is one part of California's clean air strategy. Typically, flow-control valves have a valve stem, several seals and bellows. All are common locations for VOC emissions. As such, local air district rules and regulations specify emission limits and inspection schedules (see section XIV. Suggested Operating Conditions). Because the use of the CWFC flow-control valves Models 100 and 120 is claimed to reduce fugitive VOC emissions, the ARB evaluated the valves as air pollution control equipment.

C. Health and Environmental Impacts

As part of our evaluation, staff conducted a cursory review of the potential environmental impacts associated with the CWFC's flow-control valves Models 100 and 120. Based on this review, we concluded that the valves would not likely present health or environmental impacts different from those associated with valves currently in wide use throughout California. Please note that the CWFC is required to meet all applicable health and safety standards with respect to the manufacture, installation, use, and maintenance of its flow-control valves Models 100 and 120.

D. Manufacture / Ownership Rights

The recommendations in this report are contingent upon the CWFC Corporation having the legal rights to produce and/or market flow-control valve Models 100 and 120. The CWFC documented its ownership of these rights in a letter to the ARB dated July 14, 1997, which stated, "Curtiss-Wright Flow Control Corporation confirms that we retain the ownership rights to manufacture or otherwise produce the equipment to be precertified, both in the form of precertification conditions and the requirements in the Criteria for Equipment and Process Precertification, upon the production and marketing of the equipment."

III. SUMMARY OF SCOPE

The CWFC claims that the use of its flow-control valve Models 100 and 120 will control fugitive VOC emissions associated with the handling and storage of hydrocarbons. Most fugitive VOC emissions resulting from the handling and storage of hydrocarbons are leaks from process equipment and evaporation from open areas. Generally, the control of fugitive VOC emissions involves minimizing leaks and spills through the used of efficient air pollution control equipment (including state-of-the-art flow-control valves), modifying processes, increasing monitoring and inspection frequency, and improving maintenance practices.

For purposes of this report, VOCs are considered to be any compound containing at least one atom of carbon, except exempt compounds. Exempt compounds include:

carbon monoxide
carbon dioxide
carbonic acid
metallic carbides or carbonates
ammonium carbonate
1,1,1-trichloroethane
methylene chloride
trichlorofluoromethane (CFC-11)
dichlorodifluoromethane (CFC-12)
chlorodifluoromethane (CFC-22)
trifluoromethane (CFC-23)
trichlorotrifluoroethane (CFC-113)
dichlorotetrafluoroethane (CFC-114)
chloropentafluoroethane (CFC-115)
dichlorotrifluoroethane (CFC-123)
2-chloro-1,1,1,2-tetrafluoroethane (HCFC-124)
pentafluoroethane (HFC-125)
1,1,2,2-tetrafluoroethane (HFC-134
tetrafluorethane (HFC-134a)
dichlorofluoroethane (HCFC-141b)
chlorodifluoroethane (HCFC-142b)
1,1,1-trifluoroethane (HFC-143a)
1,1-difluoroethane (HFC-152a)

and the following four classes of perfluorocarbon (PFC) compounds:

1. cyclic, branched, or linear, completely fluorinated alkanes;
2. cyclic, branched, or linear, completely fluorinated ethers with unsaturations;
3. cyclic, branched, or linear, completely fluorinated tertiary amines with no unsaturations; and
4. saturated perflorocarbons containing sulfur and with sulfur bonds only to carbon and fluorine atoms.

IV. STATEMENT OF CLAIMS

The following are the claims verified by ARB staff concerning the CWFC flow-control valve Models 100 and 120. The verification of these claims is predicated on the presumption that the flow-control valves are installed and operated in accordance with the manufacturer's installation and operating instructions.

1. **The Curtis Wright Flow Control Corporation Model 100 flow-control valve is a closed system without the potential for fugitive VOC emissions.**

2. **The Curtiss-Wright Flow Control Corporation Model 120 flow-control valve has a calculated fugitive VOC emission rate that is no greater than 5.0E-8 kg per hour (.001 pounds per year).**

3. **The Curtiss-Wright Flow Control Corporation Model 120 flow-control valve showed no performance degradation after 112,109 cycles with respect to fugitive VOC emissions**.

V. MATERIALS AVAILABLE FOR EVALUATION

The following materials were used as part of our evaluation of the CWFC's flow-control valve Models 100 and 120:

1. Request to Determine Eligibility for ARB Precertification from Mr. James D. White of the Curtiss-Wright Flow Control Corporation to Chairman John Dunlap of the ARB transmitting the Determination of Eligibility application, June 3, 1996.

2. Application for the ARB Equipment Precertification Program from Mr. James D. White to Mr. Raymond E. Menebroker of the ARB transmitting the application for the ARB precertification program, April 11, 1997.

3. Curtiss-Wright Flow Control Corporation, General Reference Book for Model 100 "Leakless" Control Valves and Model 120 "Leakproof" Control Valves, September 22, 1997.

4. Target Rock Corporation, Quality Assurance Manual, Revision E, April 2, 1996.

5. Memorandum from Mr. Raymond E. Menebroker of the ARB's Stationary Source Division to Mr. George Lew of ARB's Monitoring and Laboratory Division requesting assistance in the evaluation of a testing protocol for the CWFC flow-control valves models 100 and 120, June 3, 1997.

6. Letter from Mr. Richard Corey of the ARB to Mr. Kurt Walderon of the Chevron Pipe Line Company, July 25, 1997, thanking Mr. Walderon for the field tour where the CWFC flow control valve Model 120 is in use.

7. Letter from Mr. Steven R. Pauly of the Curtiss-Wright Flow Control Corporation to Mr. Richard Corey of the ARB transmitting the CWFC precertification application to the ARB, July 14, 1997.

8. Letter from Mr. Steven R. Pauly of the Curtiss-Wright Flow Control Corporation to Mr. Glenn B. Simjian of the ARB providing clarification of items in the CWFC application, July 28, 1997.

9. Letter from Mr. Richard Corey of the ARB to Mr. Steve R. Pauly of the Curtiss-Wright Flow Control Corporation confirming receipt of the application package, July 31, 1997.

10. Code of Federal Regulations, Title 40, Part 60, Appendix A, Reference Test Method 21, Determination of Volatile Organic Compound Leaks, U.S. Government Printing Office Washington, D.C., June 22, 1990.

11. Air Resources Board, California Clean Air Act Guidance for the Determination of Reasonable Available Control Technology for The Control of Fugitive Emissions of Volatile Organic Compounds from Oil and Gas Production and Process Facilities, Refineries, Chemical Plants, and Pipeline Transfer Stations, December 8, 1993.

12. Letter from Mr. Steven R. Pauly of the Curtiss-Wright Flow Control Corporation to Mr. Glenn B. Simjian of the ARB transmitting the testing protocol for flow-control valve Models 100 and 120, September 12, 1997.

13. Letter from Mr. George Lew of ARB's Monitoring and Laboratory Division to Mr. Raymond E. Menebroker of ARB's Stationary Source Division approving Curtiss-Wright's testing protocol, September 22, 1997.

14. Letter from Mr. Richard Corey of the ARB to Mr. Steven R. Pauly of the Curtiss-Wright Flow Control Corporation approving the CWFC's testing protocol for flow-control valve Models 100 and 120, September 26, 1997.

15. Letter from Mr. Steven R. Pauly of the Curtiss-Wright Flow Control Corporation to Mr. Richard Corey of the ARB requesting approval to modify flow-control valve Model 120, November 14, 1997.

16. Letter from Mr. Richard Corey of the ARB to Mr. Steven R. Pauly of the Curtiss-Wright Flow Control Corporation approving the modification to flow-control valve Model 120, November 18, 1997.

17. Report from Mr. Steven R. Pauly of the Curtiss-Wright Flow Control Corporation to Mr. Richard Corey documenting the testing results for flow-control valve Models 100 and 120, January 13, 1998.

18. Curtiss-Wright Flow Control Corporation, Pre-Certification Report for Model 100 and 120 Control Valves, Fugitive Emissions Evaluation and Test Program (Project 97X-130 TRP No. 6319), January 13, 1998.

For information on how to obtain these materials, please contact the ARB at the number provided at the beginning of this document.

VI. TECHNOLOGY DESCRIPTION

The CWFC flow-control valve Models 100 and 120 are a departure from the standard air-or motor-operated valve design typically used for the storage and handling of hydrocarbons. Specifically, the Models 100 and 120 flow-control valves are solenoid-actuated; they do not use a stem, packing, or bellows. Further, flow-control valve models isolate all moving parts within the process pressure boundaries. The Model 100 flow-control valve is completely seal-welded, whereas the Model 120 flow-control valve is seal-welded except for one body-to-bonnet joint sealed with an O-ring (**figure 1 and 2**).

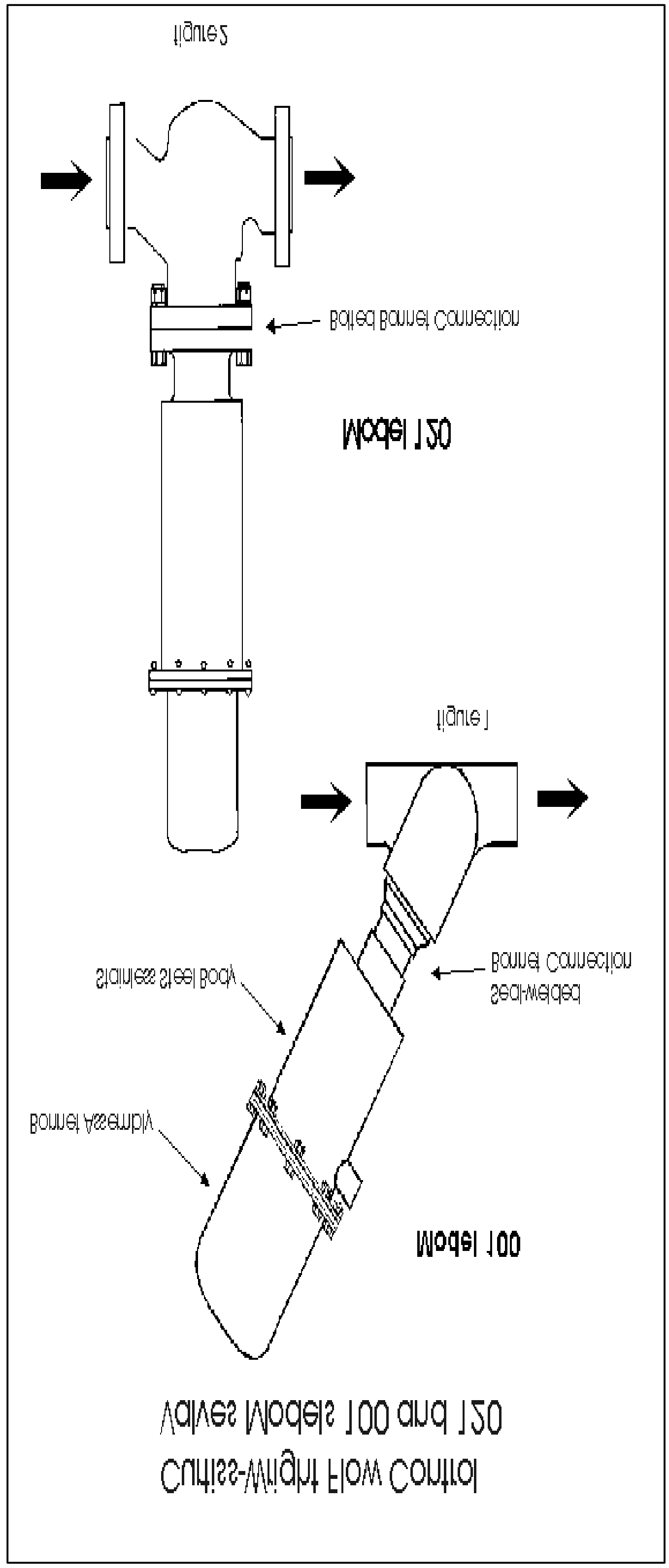
The CWFC flow-control valves are used to control the flow of liquids, steam, or gases. These valves are solenoid-actuated and employ a pilot disc to assist actuation. The two basic designs are on/off isolation valves and modulating control valves each with hard or soft seats and in either fail open or fail closed configurations. As shown in **figure 3** (typical), the stainless steel bonnet assembly, which encloses the moving parts (plunger, discs, connecting rods, and part of the position sensor assemblies), is either threaded and seal-welded to the valve body (Model 100) or bolted with an O-ring seal to the valve body (Model 120). The solenoid assembly, electrical hardware, and other parts of the position sensor assembly, are mounted on the outside of the bonnet assembly.

Modulating control valves use a linear variable differential transformer (LVDT) as a position sensor (**figure 3**). On/off isolation valves use reed switch assemblies activated by a magnet assembly (**figure 4**) inside the bonnet for position indication. Both the Model 100 and 120 flow-control valves are designed to operate on AC or DC voltage.

As shown in **figure 4,** operation of the flow-control valves occurs when the solenoid assembly is energized. It develops a magnetic field, which lifts the plunger. This pulls the pilot off its seat in the main disc opening the vent port. This changes the differential pressure between the top and bottom surfaces of the main disc, which raises the main disc in servo motion to the pilot, and allows the fluid at the inlet to flow.

When the solenoid assembly is de-energized, eliminating the magnetic force on the plunger, the return spring seats the pilot disc in the vent port. As shown in **figure 4**, with the vent ports closed, the control pressure above the main disc increases. When the control pressure increases sufficiently, the combined influence of the differential pressure and the return spring exerts a downward force on the main disc, seating it in the body, thereby closing the valve.

As the main disc moves, the motion is transmitted through the plunger to the position sensor element inside the pressure boundary. The internal movement is sensed by the external element of the position sensor assembly to signal the valve's position. In the absence of differential pressure, the solenoid coil develops sufficient force to fully open the valve directly.



Model 120 Cutaway

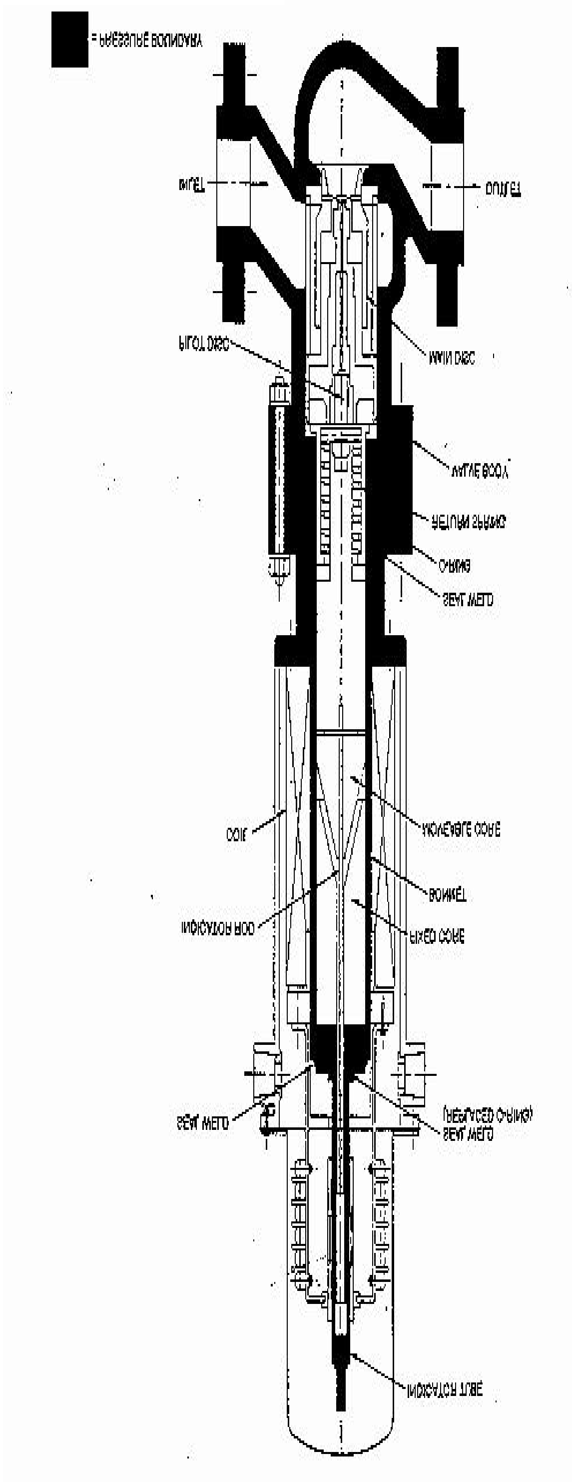
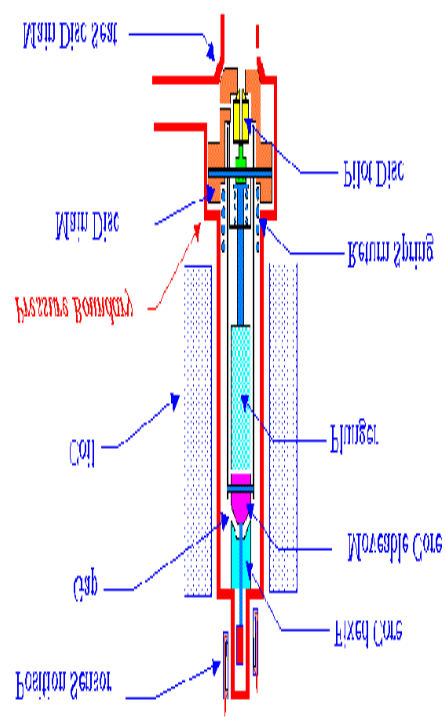


figure 4



Curtiss-Wright Flow Control Valve Cutaway

The CWFC flow-control valve Models 100 and 120 differ from standard flow-control valves in several respects. Specifically, the Model 100 and 120 valves do not have a stem, packing, or bellows. Furthermore, the Model 100 does not have a bonnet flange. These components are eliminated because they are traditionally weak spots for leaks, fugitive emissions, or failure. The CWFC believes that by replacing these components, leaks from the following areas are eliminated:

1. Stem seal - this is a dynamic (moving) seal between the packing and the externally-actuated stem. The movement may be rotational, linear, or a combination of the two. This is the most common point where valves leak. The stem leakage rate almost always contributes the bulk of the total fugitive emissions.

2. Packing gland - this is a static seal between the packing and the valve body. This is also a common leak point, and as such can influence fugitive emissions from flow-control valves.

3. Bellows - the bellows is a flexible barrier that provides additional protection against fugitive emissions from typical valves. However, over time bellows can develop cracks leading to leaks.

In addition to not having a stem, packing gland, or bellows, the CWFC's Model 100 flow-control valve does not have a bonnet flange. The bonnet flange is a static seal between the upper and lower sections of the valve. It is typically a flanged connection, but may sometimes be screwed or welded. Bonnet flange leaks are less common than leaks from stem seals and packing glands.

The CWFC's flow-control valve Model 120 has a bonnet joint-sealed with an O-ring. As this is a potential location for fugitive emissions, the Model 120 was subjected to the testing procedures described in Section VII.

VII. <u>TECHNICAL EVALUATION</u>

A. <u>Design Review:</u>

Radian International, as a contractor to the CWFC, performed an independent design review of the flow-control valves Models 100 and 120. Based upon the materials evaluated as part of this report (see section V, <u>Materials Available for Evaluation</u>), including the design review conducted by Radian International, ARB staff has verified the following:

<u>Model 100</u>

It was determined that it was not necessary to test the Model 100 (**figure 1**) flow-control valve for fugitive VOC emissions because it is completely seal-welded. The CWFC requested that the Model 100 flow-control valve be verified as equivalent (from an emissions perspective) to four welded connections. In short, properly-welded connections do not have fugitive VOC emissions. As such, when properly installed and operated, the Model 100 flow-control valve would not have fugitive VOC emissions.

<u>Model 120</u>

The Model 120 flow-control valve is seal-welded except for one body-to-bonnet joint **(figure 2)**, sealed with one O-ring. This feature should enable the valve to reduce fugitive emissions as compared to more typical valves. The CWFC requested that the Model 120 flow control valve be verified as equivalent (from an emission perspective) to three welded connections and one flanged connection. The Model 120 flow-control valve that was tested on October 29, 1997 had two O-ring seals. One of the O-ring seals was at the main body-to-bonnet joint as described above. A second **(figure 3)** O-ring seal was located at the indicator tube-to-bonnet joint. However, on November 14, 1997, the CWFC notified the ARB that it intended to replace the second O-ring with a seal-weld. After receiving approval to modify the test plan from the ARB, a second test reflecting the modification was performed on December 17, 1997.

Figure 3 is a cut away view of the flow-control valve Model 120, showing the pressure boundary, location of the seal welds, and the O-ring. These are areas where emissions could possibly occur. For Model 120 flow-control valves, three of four pressure boundary joints are completely seal-welded. However, the body-to-bonnet joint is sealed with an elastomer O-ring (the pressure boundary is shaded in **figure 3**). All seals are static seals; there are no moving seals like conventional stem seals. In addition, all of the joints are flanged seals or are welded. The flanged joints are highly engineered and controlled to eliminate the lateral stresses that exist on similar flanged connectors in plant piping systems and can contribute to connector emissions.

B. Description of Test Protocol

Prior to conducting an emissions test of flow-control valve Model 120, we requested that a test protocol be prepared. We received a test protocol from the CWFC on September 12, 1997. We approved the test protocol and notified the CWFC of our determination on September 26, 1997.

Radian International used the United States Environmental Protection Agency (U.S. EPA) Reference Test Method 21 (Determination of Volatile Organic Compound Leaks) for the testing of flow-control valve Model 120. The testing of Model 120 consisted of two phases. The key elements of the two phases of the tests are as follows:

Phase I - Pre-Acceleration Wear Testing (Model 120):

1. Pressurize the valve to 300 pounds per square inch gas (psig) with methane
2. Screen the valve for any sign of leakage using U.S. EPA Reference Test Method 21
3. Perform a blow-through bag test to measure leakage
4. Screen the valve for any sign of leakage using U.S. EPA Reference Test Method 21
5. Depressurize the valve and return it to the manufacturer for accelerated wear testing and modifications.

Phase II - Post-Acceleration Wear Testing (Model 120):

1. Pressurize the valve to 300 psig with methane
2. Screen the valve for any sign of leakage using U.S. EPA Reference Method 21
3. Perform a blow-through bag test to measure leakage
4. Screen the valve for any sign of leakage using U.S. EPA Method 21.

Phase I of the testing of Model 120 was performed on October 29, 1997. The valve was then sent back to the CWFC where the modifications (o-ring replaced with seal weld) were made and a 112,109 valve cycle test was performed (**figure 5**). After the cycle test was completed, the valve was returned to Radian International for Phase II of the test on December 17, 1997.

Phase II of the test was identical to Phase I for the purposes of the emissions testing. The purpose of the second phase of testing was to verify that the Model 120 flow-control valve had no increase in fugitive emissions after 112,109 total cycles. Methane was used in this test because it is a light-end hydrocarbon and, as such, is an excellent surrogate for detecting fugitive VOC emissions.

The accelerated wear test was initiated once the valve was returned to the factory after the first phase of testing. The valve was installed in the test loop shown in **figure 5**. The valve was pressurized with shop air at room temperature at approximately 100 psig. The outlet needle valve was throttled down to limit outlet flow as necessary. The valve's position indicator circuit was connected to a system that relayed the position signal to a cycle counter. The valve was checked at least three times a day to record the number of cycles completed. An accumulator, to stabilize supply pressure, and a muffler were also included in the testing loop. The test was administratively terminated when 112,109 cycles were achieved.

VIII. EVALUATION OF CLAIMS:

This section presents additional information relating to the claims verified by ARB staff as part of its evaluation. As stated earlier, the ARB staff evaluation and recommendations, as presented in this report, are predicated on the expectation that the flow-control valves are installed and operated in accordance with the instructions.

To assist the reader, each of the claims identified on page 4 (IV. Statement of Claims) are repeated in this section. Following each, are supporting comments which may be helpful in interpreting the significance of each claim.

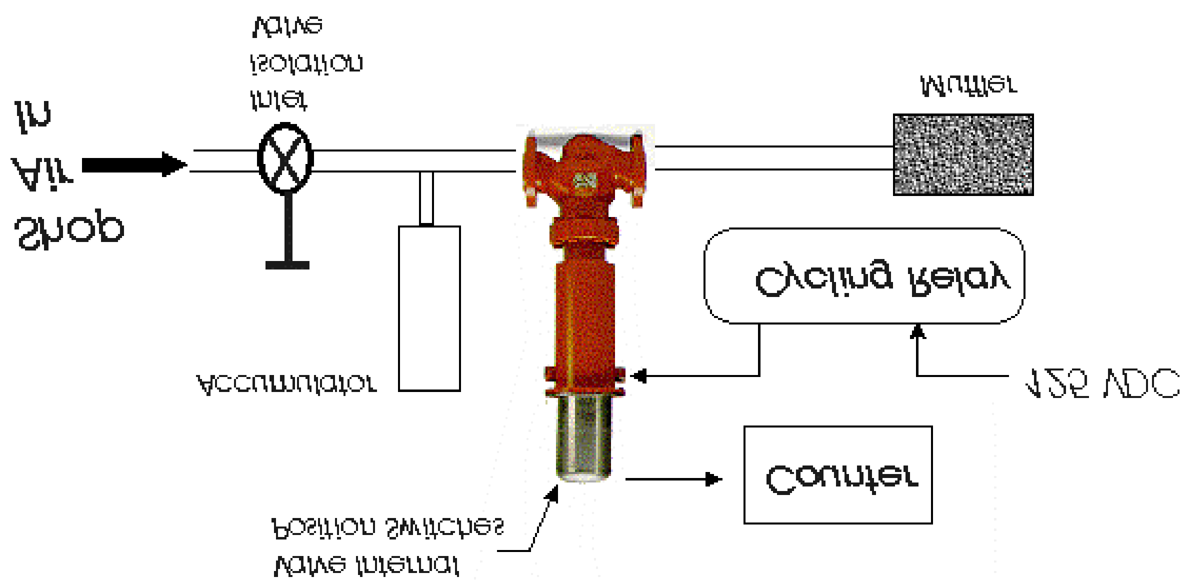
1. **The Curtiss-Wright Flow Control Corporation Model 100 flow-control valve is a closed system without the potential for fugitive VOC emissions.**

Based on our evaluation, the CWFC Model 100 flow-control valve should be treated as four welded connections from the perspective of fugitive VOC emissions. Given that properly-welded connections form a complete seal, no fugitive VOC emissions would be expected. As such, the valve would not be expected to require monitoring beyond that appropriate for welded connections.

2. **The Curtiss-Wright Flow Control Corporation Model 120 flow-control valve has a calculated fugitive VOC emission rate that is no greater than 5.0E-8 kilograms per hour (.001 pounds per year).**

The emission rate presented in the claim is an upper-bound estimate (i.e., actual emissions are expected to be lower). The upper-bound emission rate was calculated by considering the fact that the test gas (methane) used as a surrogate for fugitive VOC emissions was *not detected* at the lower limit of detection (1 ppm) of the analyzer used in the emissions test of the CWFC Corporation Model 120 flow-control valve. As is typically the case for emission results which are below the limit of detection, one-half of the detection limit was used in the calculation of a fugitive VOC emission rate for the Model 120 flow-control valve.

From the perspective of fugitive VOC emissions, the CWFC Model 120 flow-control valve should be treated as a seal-welded unit with one flanged figure 6



Curtiss-Wright Cycle Test Loop

3. **The Curtiss-Wright Flow Control Corporation Model 120 flow-control valve showed no performance degradation after 112,109 cycles with respect to fugitive VOC emissions**.

This was documented by our evaluation of the emissions test results. Specifically, after 112,109 cycles, methane was not detected in any of the tests of the O-ring seal in the bonnet-to-body joint.

IX. TEST RESULTS:

The testing protocol for the CWFC flow-control valve Model 120 employed the U.S. EPA Reference Test Method 21 in conjunction with the procedure described in the Protocol for Equipment Leak Emissions Estimates (United States Environmental Protection Agency, Publication Number EPA-453/R-39-026). The CWFC received the ARB's approval on September 26, 1997, to use the test protocol in the emissions testing. The summary of the test results submitted by the CWFC are presented in **Appendix A**.

The bonnet-to-body joint of the CWFC Model 120 flow-control valve was tested in the Radian Corporation laboratories before and after an accelerated wear test consisting of 112,109 open/close cycles. Two bag tests were performed before the accelerated wear test and three bag tests were performed after the accelerated wear test. One pre-acceleration bag test was conducted at a nitrogen flow rate of 2 liters per minute, while the other was conducted at 7 liters per minute. The post-acceleration bag tests were all conducted at nitrogen flow rates of approximately 2 liters per minute.

The purpose of the accelerated wear test was to demonstrate that the CWFC Model 120 flow-control valve showed no degradation, with respect to emissions, after a specific amount of use. An article appearing in Valve Magazine, entitled "Testing to the Fugitive Emission Standards", (included in Appendix B) was the basis for selection of the number of cycles in the test. The article referred to the use of 100,000 cycles as an appropriate value to use to evaluate accelerated wear in high performance control valves.

A Radfisch total hydrocarbon analyzer with a lower detection limit of 1 part per million (ppm) was used to detect hydrocarbons. Methane was chosen as the test gas because, as a light-end hydrocarbon, it is an excellent surrogate for detecting fugitive VOC emissions. Methane was not detected at the lower limit of detection (1 ppm) of the analyzer in any of the pre-acceleration or post-acceleration bag tests. Using the ARB's standard approach for evaluating emissions data which are below the detection limit, one-half of the detection limit was used in the calculation of the fugitive VOC emission rate for the Model 120 flow-control valve.

Test run number F3 was chosen as the basis for the emissions calculation because it represented the most conservative (highest) estimated emission rate. A calculation of the emission rate for the pre-accelerated wear test is presented on the following page.

In summary, the CWFC flow-control valve Model 120 valve had no detectable emissions before or after the accelerated wear test. As stated in the claims section of this report, the resulting VOC fugitive emission rate from the bonnet-to body joint was calculated to be no greater than 5.0E-8 kilograms per hour, which is equivalent to approximately 0.001 pounds per year.

Kilograms of volatile organic compounds (VOC) per hour =

$$\left[HC\right] \times \left[\frac{CGMW}{(MV \times NC)}\right] \times \left[\frac{N}{1 - (OR + VC)}\right] \times \left[WL\right]$$

Where:

VC = VOC concentration (reported as methane)

CGMW = Molecular weight of calibration gas (methane)

MV = Molar volume at normal conditions, 0 degrees Celsius (0°C)

NC = Conversion of normal cubic meters per hour at 0°C to cubic meters per hour at 1 atm

N = Flow rate of nitrogen

OR = Ratio of oxygen concentration in sampling device, to oxygen concentration in ambient air

WL = Factor to convert from grams per minute (g/min) to kilograms per hour (kg/hour)

Inputs for test run:

$VC = 0.5 \times 10^{-6}$

CGMW = 16 grams/mole

MV = 22.413 L/mole

$NC = \frac{22°C + 273°C}{273°C} = 1.08$

N2 = 2.0 L/min

$WL = \frac{.06\ kg/hr}{g/min}$

OR = 4.5% / 21% = .21

Note: 22°C was ambient temperature during testing

Test run calculations:

$$\left[0.5 \times 10^{-6}\right] \times \left[\frac{16\ g/mole}{22.413\ L/mole \times 1.08}\right] \times \left[\frac{2\ L/min}{[1 - (.21 - 0.5 \times 10^{-6})]}\right] \times \left[\frac{.06kg/hr}{g/min}\right] =$$

$$\left[0.5 \times 10^{-6}\right] \left[\frac{16}{24.21}\right] \left[\frac{2}{.79}\right] \left[.06\right] =$$

$$\left[0.5 \times 10^{-6}\right] \left[.66\right] \left[2.53\right] \left[.06\right] =$$

5.0×10^{-8} kilograms of VOCs per hour

X. QUALITY MANAGEMENT

The CWFC has developed extensive quality management practices and standards for its flow-control valve Models 100 and 120. The standards are described in the CWFC, Target Rock Corporation Quality Assurance Manual, Revision E, April 2 1997. This Manual incorporates the provisions of Sections I and VIII of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code. The Manual contains established quality management practices for the following areas:

-- Design, Drawing, Specification
-- Material Control and Procedure Control
-- Process Control
-- Inspection and Testing
-- Control of Measuring
--Valve Stamping and Test Equipment Sealing
-- Record Retention
-- Forms

The CWFC's Quality Management Program was reviewed by ARB staff as part of our evaluation of flow-control valves Models 100 and 120. As a result of our evaluation, ARB staff has determined that the quality management program is sufficiently comprehensive to support certifying the CWFC flow-control valve Models 100 and 120.

XI. ENVIRONMENTAL AND ECONOMIC BENEFITS

As part of our review, we evaluated the potential air quality impacts of the flow-control valve Models 100 and 120. The use of the flow-control valves will likely result in a reduction of fugitive VOC emissions when compared to traditional valves with a stem, packing, and bellows.

As part of our evaluation, we also contacted current users of the CWFC flow-control valves. The users of the flow-control valves, which were from various industries, indicated that the flow-control valves have a significantly longer life, with less required maintenance, than conventional flow-control valves. The ARB staff also visited a petroleum bulk terminal where one of the flow-control valves has been used successfully for several years. It should be noted that under certain conditions, emission reductions resulting from the installation of the CWFC flow-control valves may be eligible for emission reduction credits. Therefore, appropriate air districts in California should be consulted to determine the eligibility for any emission reduction credits.

XII. RECOMMENDATIONS

After evaluating the information discussed in this report, ARB staff recommends that the CWFC flow- control valve Models 100 and 120 be certified under its Equipment Precertification Program. Specifically, we have independently verified the claims of the CWFC concerning its flow-control valves Models 100 and 120, as presented in the claims section of this report.

By accepting certification under the ARB's program, the CWFC assumes, for the duration of the three-year certification period, responsibility for maintaining the quality of the manufactured equipment and materials at a level equal to or better than was provided to obtain this certification. Certification under the ARB's program is also contingent on the recipient agreeing to be subject to quality monitoring by the ARB as provided by law.

The ARB makes no express or implied warranties as to the performance of the manufacturer's product or equipment. Nor, does the ARB warrant that the manufacturer's product or equipment is free from any defects in workmanship or material caused by negligence, misuse, accident, or other causes. The ARB staff believes, however, that the CWFC's flow-control valves Models 100 and 120 will achieve performance levels presented in the claims section of this report. Our determination is based on our evaluation of the data submitted by the CWFC, as well as the other information identified in this report. Our recommendations are predicated on the expectation that installation and operation of the valves are performed in accordance with the manufacturer's specifications.

XIII. SUGGESTED OPERATING CONDITIONS

In California, stationary sources are permitted at the local level by districts. Each of California's 35 districts have rules and regulations which must be met to receive and maintain an air quality permit. The district rules and regulations reflect federal and state regulatory requirements as well as any additional requirements that the district boards determine to be appropriate for the region.

Technologies which have been certified under the ARB's Equipment Precertification Program are subject to the same federal, state, and local permitting requirements as sources which have not been certified. In short, receipt of a certificate under the ARB's Equipment Precertification Program does not in anyway limit the authority of local air districts. However, it is expected that local air districts will have an interest in considering the information presented in this report when making permitting decisions. Therefore, we have included some information on inspection frequency that districts may consider helpful when making permitting decisions on the valves discussed in this report.

After it has been determined that the valve has been properly installed, the inspection recommendations differ for the Model 100 and Model 120 flow-control valves. Specifically, it is recommended that the Model 100 be inspected on a frequency consistent with that which applies to welded pipe. That is because, if properly installed, the Model 100 does not include any features which would suggest that there is a potential for fugitive emissions.

For the Model 120, quarterly to semi-annual inspections (using a leak detection instrument) are suggested for the first year. A measurement of 10,000 parts per million or greater should be considered a leak. If four consecutive readings below 100 parts per million or less are recorded, it is recommended that the inspections be conducted annually.

If, during any inspection, a reading of 10,000 parts per million or greater is recorded, it is recommended that the valve be repaired and that quarterly inspections be resumed. Alternatively, if any readings are over 100 parts per million but less than 10,000 it is suggested that the cause of the reading be investigated and that the valve be repaired if needed. After any repair is completed, it is suggested that inspections take place on a quarterly basis until four consecutive readings below 100 parts per million are made, then return to annual inspections.

XIV. PRECERTIFICATION CONDITIONS

The recommendations in this report are conditional on the flow-control valves being installed, inspected and maintained, in accordance with the CWFC operator's manual and the CWFC General Reference book. In order for the precertification to remain valid, the CWFC must retain manufacturing rights to the flow-control valves Models 100 and 120.

Appendix A

Test Results for Curtiss-Wright Flow Valve Model 120

For more information, contact the
Office of Environmental Technology at (916) 327-5789.

Appendix B

Article Entitled "Testing to the Fugitive Emissions Standards," Value Magazine

For more information, contact the Office of Environmental Technology at (916) 327-5789.